

Hydrocarbon Sensor for Exhaust Gas Monitoring

A.Q. Pham, J. H. Visser, S. Ejakov, R. S. Glass

This article was submitted to
52nd Pacific Coast Regional and Basic Science Division Meeting,
San Francisco, CA., September 6-9, 2000

August 28, 2000

U.S. Department of Energy

Lawrence
Livermore
National
Laboratory

DISCLAIMER

This document was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor the University of California nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or the University of California, and shall not be used for advertising or product endorsement purposes.

This is a preprint of a paper intended for publication in a journal or proceedings. Since changes may be made before publication, this preprint is made available with the understanding that it will not be cited or reproduced without the permission of the author.

This work was performed under the auspices of the United States Department of Energy by the University of California, Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

This report has been reproduced directly from the best available copy.

Available electronically at <http://www.doc.gov/bridge>

Available for a processing fee to U.S. Department of Energy
And its contractors in paper from
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
Telephone: (865) 576-8401
Facsimile: (865) 576-5728
E-mail: reports@adonis.osti.gov

Available for the sale to the public from
U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: (800) 553-6847
Facsimile: (703) 605-6900
E-mail: orders@ntis.fedworld.gov
Online ordering: <http://www.ntis.gov/ordering.htm>

OR

Lawrence Livermore National Laboratory
Technical Information Department's Digital Library
<http://www.llnl.gov/tid/Library.html>

Hydrocarbon Sensor for Exhaust Gas Monitoring

A.Q. Pham¹, J.H. Visser², S. Ejakov² and R.S. Glass¹

¹Lawrence Livermore National Laboratory
P.O Box 808, L-231, Livermore, CA 94550

²Ford Motor Company
Scientific Research Laboratories MD3028
20,000 Rotunda Drive
Dearborn MI 48121-2053

Due to increasing environmental concerns, in 1994, the California Air Resources Board (CARB) and the U.S. Environmental Protection Agency (EPA) began implementing regulations that require automakers to incorporate comprehensive on-board diagnostics into new vehicles. The purpose is to monitor emissions, which will allow early detection of any malfunctioning of the engine and/or exhaust treatment system. Currently, monitorings of hydrocarbon and NO_x emissions are regarded as being the most critical for evaluating car emissions.

We have developed at Lawrence Livermore National Laboratory a novel sensing approach for hydrocarbon detection (1). The novel sensor uses a high temperature proton conducting electrolyte and a dehydrogenation catalyst. Structurally, the sensor consists of the proton conductor sandwiched between two platinum electrodes. This arrangement is in essence a hydrogen sensor. When a dehydrogenation catalyst (iron oxide) is deposited on top of one of the electrodes, dehydrogenation of the hydrocarbons generates extra hydrogen on the catalyst side of the sensor. The measurement of the emf developed across the sensor is a measure of the amount of hydrocarbons present in the exhaust. This sensing mechanism does not require a reference gas. The sensor has interesting characteristics such as very high selectivity, no sensitivity to gas flow and weak temperature dependence. However, the major drawback was a large effect of oxygen concentration on sensor signal. This effect was attributed to the highly active Pt electrode, which catalyzes the oxidation of hydrogen when oxygen is present.

We have developed a second generation of this sensor. The Pt electrode is completely removed on the catalyst side. Since the iron oxide is a semiconductor with reasonable electronic conduction at high temperature, and since the sensor just requires the measurement of the voltage, the iron oxide can perform simultaneously as a dehydrogenation catalyst as well as the electrode for the proton conducting electrolyte.

The new sensor has been characterized in a variety of gases, including oxygen, ethane, propylene, carbon monoxide, hydrogen and water in nitrogen. The sensor shows similar characteristics as the previous generation. However, the dependence on oxygen concentration in exhaust gas is significantly reduced. Due to reduce sensitivity to oxygen content, the new sensor can be used in both lean-burn and fuel-rich conditions.

References

1. A.Q.Pham and R.S. Glass, "A Novel Hydrocarbon Sensor for On-Borad Emission Monitoring", Meeting Abstract, 193th Electrochemical Society Meeting, San Diego, May 1998.

Acknowledgments

Work performed under the auspices of the US Department of Enery by the Lawrence livermore National Laboratory under contract W-7405-Eng-48.